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**Original Research Article**

# Patterns in flexor zone V injury: a retrospective study

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## ABSTRACT

**Background:** Volar cut injuries to the wrist that range from simple to complex full house and are commonly encountered by plastic surgery residents. In this study we aim to recognize common clusters of structures injured together, to decipher patterns in presentation and to assert the role of superficial tendons in protecting the nerves, vessels and the deeper tendons in the flexor compartment.
**Methods**: This is a retrospective cross-sectional study analyzing 322 patients with acute Zone V injuries. The patients were profiled based on demographic factors and etiology of injury. Detailed analysis of morphology of injury, structures involved was done and grouped into six common injury patterns.
**Results:** Majority of subjects were in the age group 21 to 30 years (33.9%), 81.1% were males and 18.9% were females. Both the sides flexor carpi radialis, Palmaris longus and flexor digitorum superficialis were commonly injured structures. Most common etiology was cutting tools. The median number of structures injured in cutting injuries was 3, in deliberate self-harm was 3, in Power tool was 6, in Shard injuries was 5 structures. Distribution of injuries was pattern 1 (98.2%), pattern 2 (36.2%), pattern 3 (40.5%), pattern 4 (80.1%), pattern 5 (15.6%) and pattern 6 (21.5%). Pattern 1 was seen commonly in all etiologies whereas power tools were responsible for serious pattern 6 types of injuries.
**Conclusions:** Cut injury to wrist occurs as clusters of specific structures and these patterns need to be looked for during surgical repair of hand. Superficial tendons have a role in protecting deeper tendons and neurovascular structures.

**Keywords:** Zone V injury, Wrist laceration, Tendon injury, Patterns of hand injury

## INTRODUCTION

The hand has a very important role in the activities of daily living. The complexity of the structures passing through the volar aspect of the wrist is such that injury to wrist results in significant functional deficit if not addressed promptly. The flexor tendon region of the upper limb is classified into 5 zones (Figure 1). Zone V injury, i.e., the injury to the volar aspect of the wrist is a commonly encountered case in the emergency room.[1]

Though extensor tendon injuries are more common compared to flexor zone injuries in the upper limb, it is the flexor injuries that challenges the plastic surgeon or a

hand surgeon more during training and in clinical practice due to the critical structures encountered, including the neurovascular bundle. These injuries can range from a simple superficial cut to a complex full house injury.[2]

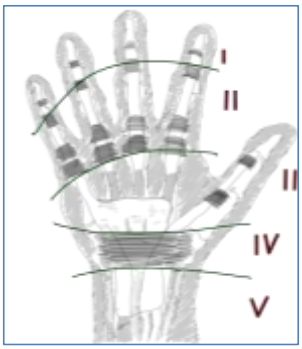


**Figure 1: Flexor Zones of hand by Verdan.**

Volar zone V (Figure 2) injury of upper limb to the wrist that range from simple to complex full house and are commonly encountered by plastic surgery residents. And to recognize the common patterns in presentation. In this study we aim to recognize common clusters of structures injured together, to decipher patterns in presentation and to assert the role of superficial tendons in protecting the nerves, vessels and the deeper tendons in the flexor compartment.

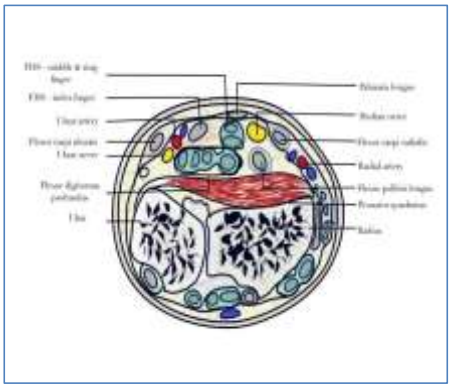

**Figure 2: Flexor Zone V.**

## METHODS

We conducted a retrospective cross-sectional study analyzing data collected from the medical records of 322 patients who presented with acute hand injuries involving the flexor Zone V at the Government Medical College, Calicut over a period of 3 years from 2018 to 2021.

***Inclusion and exclusion criteria***

Patients who were admitted with an acute injury to the volar aspect of wrist with vital structure involvement in the last 5 years and Patients above 18 years were included in the study. Patients with pre-existing diseases and previous hand trauma were excluded in the study.

The patients were profiled based on demographic factors and etiology of injury. Detailed analysis of morphology of injury, structures involved was done and grouped into six common injury patterns.

**Table 1: Patterns of injury.**

| Patterns | Structures involved |
|---|---|
| **Pattern 1** | Only FCU/ FCR/ PL/ FDS single or in combination |
| **Pattern 2** | FCU with ulnar artery /nerve /both ulnar nerve and artery |
| **Pattern 3** | PL with median nerve |
| **Pattern 4** | PL, FDS with median nerve |
| **Pattern 5** | FCR with radial artery |
| **Pattern 6** | 3 or more tendons with at least one artery/nerve (includes full house) |

FCU-flexor carpi ulnaris, FCR-flexor carpi radialis, PL-palmaris longus, FDS-flexor digitorum superficialis, FDP-flexor digitorum profundus.

As the study is of retrospective nature based on records and not affecting the patient care or patient confidentiality, informed consent is not obtained from patients. The data was obtained after taking necessary permissions and no ethical concerns were present.

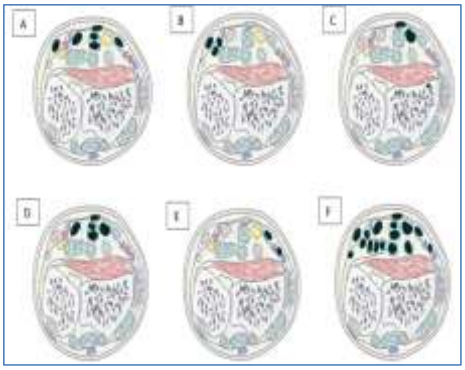

**Figure 3: Proposed patterns in flexor zone 5 injury: A) Pattern 1-FCU/ FCR/ PL/FDS single or in combination, B) Pattern 2-FCU with ulnar artery/ nerve /both ulnar nerve and artery, C) Pattern 3-PL with median nerve, D) Pattern 4-PL, FDS with median nerve, E) Pattern 5-FCR with radial artery, F) Pattern 6-3 or more tendons with at least one artery/nerve.**

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-Square test was used as test of significance for qualitative data. Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagrams. P value of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

## RESULTS

In the study, the majority of subjects were in the age group 21 to 30 years (33.9%), 81.1% were males and 18.9% were females, 51.6% had left side injury, 47.2% had right side injury and 1.2% had bilateral injury. The most common etiology for right side wrist injury was power tool (44.9%) and on left side most common etiology was cutting tool (40.6%).

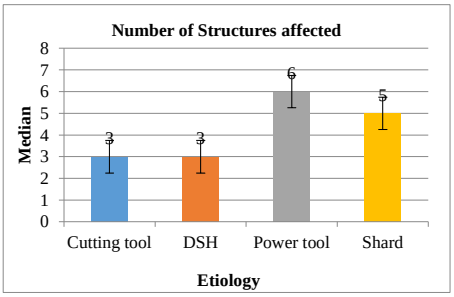


**Figure 4: Number of structures affected with respect to etiology.**

On the right side, the most common tendon injured was FDS and PL tendon (64.1%), most common artery involved was ulnar artery in 24.4% and most common nerve involved was median nerve in 49.4%. On Left side, the most common tendon injured was FCR in 50%, most common artery was radial artery and most common nerve was median nerve in 50%. between the left and right side no significant difference was noted except for FDP tendon involvement which was more on right side. Among females, most common etiology was cutting tools like kitchen knife in 51.6% and among males, most common etiology was cutting tool like woodcutters or hatchets in 40.5%. Among Females, most common tendons involved was FCR (71%), both radial and Ulnar artery is equally affected (11.3%) and most common nerve involved was median nerve. Among males, the most common tendons involved was the FDS (65.2%), the most common artery involved was the Ulnar artery in 23.1% and the most common nerve involved was the median nerve in 48.1%. The median number of structures injured in cutting tool injuries was 3, in deliberate self-harm was 3, in Power tool was 6, in Shard injuries was 5 structures. There was a significant difference in the number of structures injured with respect to etiology (Figure 4). Based on the pattern of distribution 98.2% of subjects had Pattern 1 injuries, 36.2% had pattern 2 injuries, 40.5% had pattern 3 injuries, 80.1% had pattern 4 injuries, 15.6% had pattern 5 injuries and 21.5% had pattern 6 injuries. Hence most common pattern was pattern 1 and least common was pattern 5 (Figure 5).

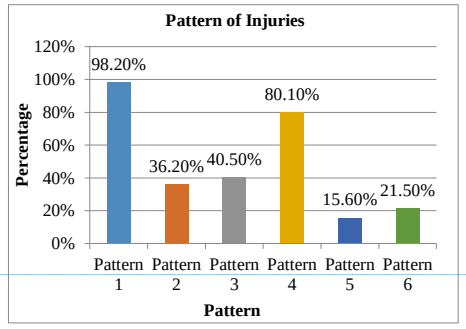


**Figure 5: Distribution of pattern of injury.**

Regarding correlation between patterns of injury and etiology Pattern 1 injuries were highest in Power tool injuries (100%) and least in DSH injuries.

**Table 2: Pattern of Injuries with respect to etiology.**

| Etiology | Cutting tool (N=139) (%) | DSH (N=40) (%) | Power tool (N=63) (%) | Shard (N=84) (%) | P value |
|---|---|---|---|---|---|
| **Pattern 1** | 98.6 | 95.0 | 100.0 | 97.6 | 0.302 |
| **Pattern 2** | 26.6 | 37.5 | 55.6 | 36.9 | 0.001 |
| **Pattern 3** | 26.6 | 27.5 | 60.3 | 54.8 | <0.001 |
| **Pattern 4** | 70.5 | 75.0 | 93.7 | 88.1 | <0.001 |
| **Pattern 5** | 6.5 | 12.5 | 33.3 | 19.0 | <0.001 |
| **Pattern 6** | 5.8 | 15.0 | 46.0 | 32.1 | <0.001 |

Pattern 2 injuries were highest in Power tool injuries (55.6%) and least in Cutting tool injuries. Pattern 3 injuries were highest in power tool injuries (60.3%) and least in cutting tool injuries. Pattern 4 injuries were highest in power tool injuries (93.7%) and least in cutting tool injuries. Pattern 5 injuries were highest in power tool injuries (33.3%) and least in cutting tool injuries. Pattern 6 injuries were highest in power tool injuries (46%) and

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least in cutting tool injuries. There was a significant difference in pattern 2 to pattern 6 injuries with respect to type of etiology. There was no significant difference in pattern 1 injuries with respect to type of etiology (Table 2). In the study majority of subjects were in the age group 21 to 30 years (33.9%), 81.1% were males and 18.9% were females, 51.6% had left side injury, 47.2% had right side injury and 1.2% had bilateral injury. Hence a total of 170 left hands and 156 right hands were affected in 322 subjects.

**Table 3: Patient demographic data (n=322).**

| Parameters | | N | % |
|---|---|---|---|
| **Age (years)** | <10 | 6 | 1.9 |
| | 11 to 20 | 31 | 9.6 |
| | 21 to 30 | 109 | 33.9 |
| | 31 to 40 | 72 | 22.4 |
| | 41 to 50 | 62 | 19.3 |
| | 51 to 60 | 26 | 8.1 |
| | 61 to 70 | 11 | 3.4 |
| | 71 to 80 | 5 | 1.6 |
| **Sex** | Female | 61 | 18.9 |
| | Male | 261 | 81.1 |
| **Side** | Right | 152 | 47.2 |
| | Left | 166 | 51.6 |
| | Bilateral | 4 | 1.2 |
| **No of hands affected** | Right | 156 | 47.9 |
| | Left | 170 | 52.1 |

## DISCUSSION

Hand trauma makes up around 14 to 27% of cases presenting in an emergency department and the incidence rate of hand injuries was 33.2 per 1,00,000 person years.[3] Of all hand injuries, zone V injuries constitute 26 to 48 % of the cases.[4] The Flexor zone 5 contains 12 tendons, 2 arteries and 2 nerves. The proximity to skin makes these structures more susceptible to injury. In a study by Ihekire et al machine cutter injury was the major cause of hand trauma. Other major causes were road traffic accidents, injuries with sharp objects and deliberate self-harm. Also, right hand injuries were more common than left hand injuries & that 56.8% of patients sustained injury to their dominant hand.[5] In Our study left sided injury slightly higher than right sided injury. The most common etiology for right side wrist injury was power tool (44.9%) and on the left side most common etiology was cutting tool (40.6%). In a study on hand injuries by wood working machine, by Rajan et al Among the wood working tools, hammers, chisels/gouges, and table saws are frequently reported in association with injuries, although the highest tool-specific injury rates were associated with use of jointer-planers.[6] In our study more than 80% patients were males. Among females, most common etiology was cutting tool and among males also it was cutting tool. According to Lombardi et al where the age of subjects ranged from 18 to 77 years with mean age being 37.2 of which approximately 75% were men and majority of the subjects were employed in machine trades, service work, structural work, benchwork, whereas in our study the majority of subjects were in the age group 21 to 30 years.[7] On the methods and initial findings in hand injury by Lombardi et al initial findings in a zone V injury showed that FCU or Palmaris longus with or without median nerve injuries were the most common structures involved and that when multiple structure injuries involving more than five structures FCU with or without ulnar nerve injuries was a common finding.[8]

On injury patterns by Lee et al the barrier effects of the FCR, PL, and FCU were confirmed. The superficial position of flexor tendons, median and ulnar nerves and blood vessels in the volar wrist places them at a high risk of direct injury. The term 'spaghetti wrist' more commonly known as 'Full house injury' was originally coined by Puckett and Meyer and denoted a forearm volar laceration in which three or more structures were severed.[9] According to the study by Noaman HH an average of 9 structures was injured, including 7 tendons, 1 nerve, and 1 artery. The most frequently injured structures were median nerve (83%), FDS 2-4 tendons (81%), FDP 2-4 tendons (66%), ulnar nerve and ulnar artery (57%), and flexor pollicis longus (40%).[10] The depth of injury in case of self-inflicted injuries varied according to the gender and the mental status of the patient.[11] In our study, the FDS and PL tendon was most common tendon, most common artery involved was ulnar artery in 24.4% and most common nerve involved was median nerve in 49.4%. On Left side, the most common tendon injured was FCR in 50%, most common artery was radial artery and most common nerve was median nerve in 50%. Comparing genders while FCR was the tendon commonly involved in females, it was FDS in males. There was no difference between radial and ulnar artery involvement in females but ulnar artery was more involved in males. Regarding nerve injury, median nerve was the commonest nerve injured in both genders.

There are very few studies in literature describing patterns of flexor tendon injuries. Considering our sample size, we defined patterns after noticing structures which were commonly injured together. We found that pattern 1 injury was seen in 98.2% of cases making it evident that either FCU, FCR, PL or FDS tendons singularly or in combination were involved in almost all cases, indirectly suggesting their role in protecting the neurovascular structures and deeper tendons in zone V injury. Injury pattern 5 involving FCR & Radial artery was the least common in our study. Another important finding was that pattern 6 injury which included 'Full house' injury was more common than the pattern 5 injury. Considering the correlation between etiology and patterns of injury an important finding noted was that pattern 6 injuries were highest in power tool related injuries. Patterns though overlapping can be considered as a learning tool. In instances where the wound being small but the deficits

being out of proportion to the wound size the patterns defined in this way can serve as a guide for trainees.

***Limitations***

The limitations of the study were that patterns of injury may overlap, and multiple patterns may be seen in the same patient.

## CONCLUSION

Flexor tendon injuries occur as clusters of specific patterns, and they can serve as a guide not to miss structures that may be damaged together and the protective role of Superficial tendons in preserving deeper structures is noted.

***Recommendations***

Describing the patterns of structures involved in a flexor zone V injury will help in increased recognition of the injured structures and result in a better surgical outcome.

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*Conflict of interest: None declared*
*Ethical approval: The study was approved by the Institutional Ethics Committee*

## REFERENCES

1. Żyluk A, Piotuch B. An analysis of the effect of the technique of the repair and postoperative rehabilitation protocol on the treatment outcomes of flexor tendon injuries: a review. Pomeran J Life Sci. 2020;66(3):12-8.
2. Davas Aksan A, Durusoy R, Ada S, Kayalar M, Aksu F, Bal E. Epidemiology of injuries treated at a hand and microsurgery hospital. Acta Orthop Traumatol Turc 2010;44:352-6.
3. de Jong JP, Nguyen JT, Sonnema AJ, Nguyen EC, Amadio PC, Moran SL. The incidence of acute traumatic tendon injuries in the hand and wrist: a 10-year population-based study. Clin Orthoped Surg. 2014;6(2):196-202.
4. Alluri RK, Vakhshori V, Hill R, Azad A, Ghiassi A, Stevanovic M. A diagnostic algorithm to guide operative intervention of zone 5 flexor injuries. HSS. 2022;18(1):57-62.
5. Ihekire O, Salawu SA, Opadele T. International surgery: causes of hand injuries in a developing country. Can J Surg. 2010;53:161-6.
6. Rajan S. Reconstruction of hand injuries caused by wood working machines. Clin Orthoped Surg. 2010; 4(1):43-8.
7. Lombardi S. Acute traumatic occupational hand injuries: type, location & severity. JOEM. 2002;44(4): 345-51.
8. Sorock GS, Lombardi D, Hauser R, Eisen E, Herrick R, Mittleman M. A case crossover study of occupational traumatic hand injury: methods and initial findings. Am J Ind Med. 2001;39:171-9.
9. Lee CH, Cha SM, Shin HD. Injury patterns and the role of tendons in protecting neurovascular structures in wrist injuries. Injury. 2016;47:1264-9.
10. Noaman HH. Management and functional outcomes of combined injuries of flexor tendons, nerves, and vessels at the wrist. Microsurgery. 2007;27(6):536-43.
11. Fujioka M, Murakami C, Masuda K. Evaluation of superficial and deep self-inflicted wrist and forearm lacerations. J Hand Surg Am. 2012;37:1054-8.
12. Kisch T, Matzkeit N, Waldmann A, Stang F, Krämer R, Schweiger U, et al. The reason matters: deep wrist injury patterns differ with intentionality (accident versus suicide attempt). Plastic Reconst Surg Global. 2019;7(5):112-7.
13. Chin G, Weinzweig N, Mead M, Gonzalez M. Spaghetti wrist: management and results. Plastic Reconst Surg. 1998;102(1):96-102.

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